

High-Resolution Electron Microscopy Imaging of Plants and Pretreated Biomass

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Using sophisticated sample preparation followed by scanning and transmission electron microscopy imaging we have studied a variety of plants and pretreated biomass samples, with a focus on the effects of ionic liquid pretreatment on Switchgrass plant cell walls. We have compared ionic liquid pretreatment to other pretreatment techniques such as acid pretreatment and ammonia fiber expansion, and find ionic liquids to exhibit a much larger effect on the biomass. By imaging plant material being pretreated with ionic liquids from different time points, we found that the cell wall material shows significant changes within less than 30 minutes of exposure to ionic liquids. We utilized widefield TEM to cover a statistically significant number of cell walls in different tissues and compared their precise dimension as a function of exposure to ionic liquids. We found that only the secondary cell wall of sclerenchyma cells undergoes dramatic changes, increasing to twice its original dimension over time, whereas primary cell walls were not found to expand significantly. Interestingly, the effect of the ionic liquid pretreatment is very different for various plant feedstocks: While switchgrass and corn stover get dissolved easily there is only a minor effect on Eucalyptus arboretum. Other efforts currently underway at JBEI include cell wall characterization of Arabidopsis mutants both via optical and EM imaging as well as mechanical stress testing, and in addition imaging of lignocellulose digesting microbial communities.

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